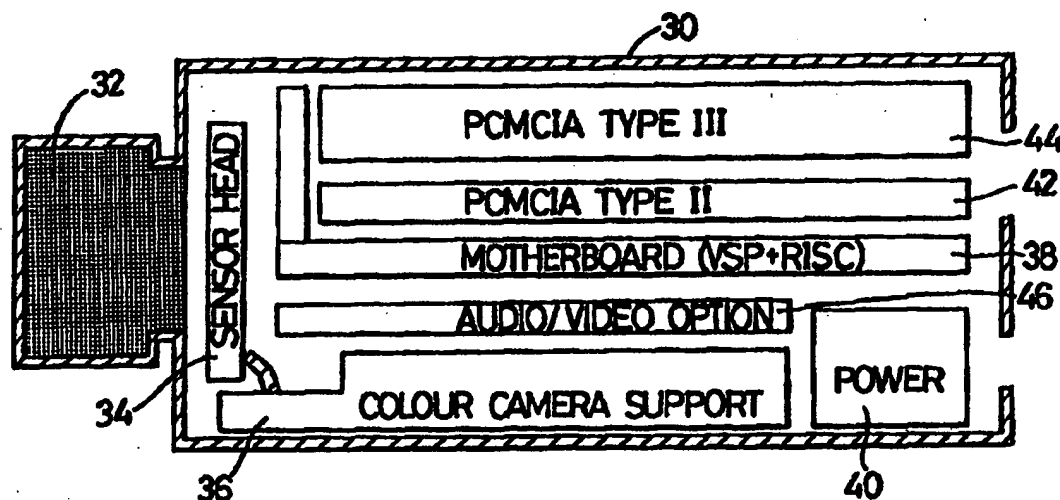




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(54) Title: **DIGITALLY NETWORKED VIDEO CAMERA****PHYSICAL CONFIGURATION.**

## (57) Abstract

A self-contained, digitally networked video camera comprises a housing (30) enclosing a camera module having video image sensor means (36) adapted to generate a video signal, signal processing means (38), including a video signal processor (VSP) which receives a digital video signal from the camera module and a multi-tasking RISC processor, adapted to compress and/or analyse said video signal and to output a digital data signal, and digital interface input/output means (42, 44), such as PCMCIA cards adapted to transmit said digital data signal to an external, digital communications network in accordance with a predetermined communications protocol, such as TCP/IP. The camera may be connected directly to a digital communications network, such as a LAN or WAN, for the transmission of compressed, digital video signals and/or associated data directly to host PC's connected to the network. Audio signals may also be processed.

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## DIGITALLY NETWORKED VIDEO CAMERA

1

2

3 This invention relates to improvements in video camera  
4 apparatus. More particularly, the invention relates to  
5 video cameras adapted for direct connection to digital  
6 communications networks, and to video cameras which can  
7 analyse what they see and/or hear and which can  
8 interface directly to digital networks.

9

10 In this field it is already known that:

11

12 1 Cameras can be interfaced to digital networks via  
13 PC's or separate dedicated control units (see, for  
14 example, GB-A-2231753; US-A-5237408; WO-A-  
15 90/09717).

16

17 2 Videophones can interface directly to some digital  
18 networks (WAN - Wide Area Networks) but are unable  
19 to perform image analysis or audio analysis for  
20 the purpose of detecting specific events and  
21 moreover cannot interface directly to Local Area  
22 Networks (LAN).

23

24 3 Analysis of images has been carried out within a  
25 camera unit (such systems are available from, for  
26 example, VLSI Vision Limited of Edinburgh, UK;  
27 Intelligent Camera, Image Inspection Limited of  
28 Epsom, UK; and MAPP/LAP, IVP, Linkoping, Sweden)

1 but never in conjunction with the ability to  
2 interface directly to digital networks.

3

4 Known cameras and systems of these types have the  
5 disadvantages that:

6

7 1 It is often impractical and not cost effective to  
8 use a PC or separate control unit to allow a  
9 camera to interface to LAN/WAN. This is  
10 especially true in circumstances where a PC would  
11 not usually be present such as in remote  
12 surveillance applications: eg construction site  
13 monitoring.

14

15 2 Existing surveillance cameras, by transmitting  
16 video in analogue form, are severely restricted  
17 in quality of transmission and recording,  
18 automation of surveillance operations,  
19 restrictions on network topologies, ability to  
20 cross-reference to other events whose occurrence  
21 is reported digitally.

22

23 3 Existing cameras which can perform image analysis  
24 cannot transmit images and the results of analysis  
25 over digital networks, thus severely restricting  
26 interpretation of results and integration of  
27 cameras with existing digital systems.

28

29 Use of digital cameras is almost exclusively oriented  
30 around PC's and workstations. The requirement for a  
31 host PC for capturing and transmitting video is  
32 circumvented by this invention. This is achieved by  
33 the integration of the hardware and software previously  
34 provided by the combination of a camera and separate  
35 computer (PC) into a single, stand-alone surveillance  
36 camera unit.

1 The benefits of this are (a) the cost reduction through  
2 not requiring a PC to be present and (b) the  
3 flexibility achieved by enabling image input to digital  
4 networks from locations where PC's cannot be used.

5  
6 This, combined with the ability to automatically  
7 analyse the acquired video and/or audio, within the  
8 camera and in real time, allows the automation of a  
9 wide range of visual/audio tasks via remote control  
10 over digital networks.

11  
12 In accordance with the present invention there is  
13 provided a video camera comprising a housing enclosing  
14 video image sensor means adapted to generate a video  
15 signal, signal processing means adapted to process said  
16 video signal and to output a digital data signal, and  
17 digital interface input/output means adapted to  
18 transmit said digital data signal to an external,  
19 digital communications network in accordance with a  
20 predetermined communications protocol.

21  
22 Preferably, said signal processing means includes a  
23 video signal processor (VSP) adapted to perform real-  
24 time image compression and/or image analysis on said  
25 video signal.

26  
27 Preferably also, said signal processing means further  
28 includes microprocessor means adapted to supervise  
29 operation of said VSP and data input/output via said  
30 interface means.

31  
32 Most preferably, said microprocessor means comprises a  
33 multi-tasking RISC processor.

34  
35 Preferably also, said VSP has first memory means  
36 associated therewith. Suitably, said first memory means

1 comprises dynamic random access memory.

2

3 Preferably also, said microprocessor means has second  
4 memory means associated therewith. Suitably, said  
5 second memory means comprises static random access  
6 memory.

7

8 Preferably also, said communications protocol is  
9 TCP/IP.

10

11 Preferably also, said interface means comprises at  
12 least one PCMCIA card.

13

14 Preferably also, the camera further includes audio  
15 sensor means, said signal processing means being  
16 further adapted to process audio signals generated by  
17 said audio sensor means.

18

19 While further modifications and improvements may be  
20 made without departing from the scope of this  
21 invention, the following is a description of one or  
22 more examples of the invention, with reference to the  
23 accompanying drawings in which:

24

25 Fig. 1 is a schematic illustration of a video  
26 camera in accordance with the invention  
27 connected to a digital network such as a LAN  
28 or WAN;

29

30 Fig. 2 is a schematic block diagram  
31 illustrating the hardware architecture of the  
32 camera of Fig. 1;

33

34 Fig. 3 is a schematic illustration of the one  
35 example of the physical configuration of the  
36 camera of Fig. 1; and

1           Fig. 4 is a schematic block diagram  
2           illustrating the software architecture of the  
3           camera of Fig. 1.

4  
5           The invention relates to a camera which can interface  
6           directly to digital networks (such as Local Area  
7           Networks (LAN's) or Wide Area Networks (WAN's)) and  
8           which can carry out real time image compression and  
9           analysis. Via the LAN/WAN it can communicate to one or  
10          more PC control stations where the compressed video can  
11          be decompressed and displayed and the results of the  
12          image analysis viewed and/or recorded in a database.

13  
14          Fig. 1 illustrates an example of such an arrangement,  
15          in which one or more cameras 10 are connected directly  
16          to the network 12, to which there are also connected  
17          one or more host PC's 14. The camera 10 digitises,  
18          compresses and analyses video images of a subject 16,  
19          and the images and/or associated analysis results are  
20          transmitted via the network 12 for display and/or  
21          recordal on the host PC 14.

22  
23          The hardware architecture of the camera 10 is  
24          illustrated in block-diagram form in Fig. 2. As seen  
25          in Fig. 2, the digitally-networked camera combines a  
26          colour camera 18, including an image sensor and,  
27          optionally, audio microphone, with a high performance  
28          Video Signal Processor (VSP) 20 and a RISC processor  
29          22. The output video/audio signals from the camera 18  
30          are input to the VSP 20, which is connected to the  
31          RISC processor 22. The processor 22 is in turn  
32          connected to network interface hardware 24. Both the  
33          VSP 20 and RISC processor 22 have memory means  
34          associated therewith. In this example, dynamic random  
35          access memory (DRAM) 26 is connected to the VSP 20 and  
36          static random access memory (SRAM) and programmable

1 read only memory (PROM, preferably Flash EPROM) 28 is  
2 connected to the RISC processor 22.

3  
4 The colour camera 18 may be of the type including an  
5 image sensor which directly outputs a digital video  
6 signal, or may have an analogue sensor output with  
7 separate analogue to digital conversion, or analogue to  
8 digital conversion means may be incorporated between an  
9 analogue camera and the VSP 20. In any case, the input  
10 to the VSP 20 is a digital video signal. The same  
11 applies to audio signals from the camera 18, if  
12 applicable.

13  
14 The VSP 20 supports real time image compression and  
15 also acts as a highly parallel ALU for real time image  
16 analysis. The RISC processor 22 supports a  
17 multitasking operating system with built-in networking  
18 and communications support, and also supervises the VSP  
19 20. External input/output (i/o) is via the network  
20 interface hardware 24; suitably, for example, via two  
21 PCMCIA slots, allowing easy interfacing to LAN, WAN,  
22 ISDN, wireless communications and mass storage devices.  
23 It will be appreciated that digital network interfaces  
24 may be provided by means other than PCMCIA-type  
25 devices.

26  
27 The camera also includes a proprietary digital gate  
28 array (not shown), which implements bus bridges between  
29 the major functional units of the architecture and  
30 contributes to the high integration and low cost of the  
31 camera unit.

32  
33 This entire functionality is integrated within a single  
34 camera unit. Fig. 3 shows an example of the physical  
35 configuration of such a unit. In Fig. 3, a housing 30  
36 supports the camera optics 32 and encloses the image



1 sensor 34 and associated electronics 36 of the camera  
2 18; a motherboard 38 mounting the VSP 20, RISC  
3 processor 22, DRAM 26, SRAM 28 and other associated  
4 electronic components; a power supply unit 40; network  
5 interface hardware such as type II and type III PCMCIA  
6 cards 42, 44; and, possibly, additional, optional  
7 audio/video hardware 46. It will be understood that  
8 the illustrated physical configuration is given by way  
9 of example only and may be varied while still  
10 maintaining the essential functionality of the  
11 invention.

12  
13 The RISC processor 22 supervises the execution of image  
14 processing and/or compression functions performed by  
15 the VSP 20. The RISC processor 22 also supports a  
16 real-time operating system (RTOS). The software  
17 architecture of the camera is illustrated  
18 schematically in Fig 4. This allows genuine  
19 multitasking, which is essential in the environment.  
20 In parallel, the RISC processor 22 supervises video  
21 capture, compression, image processing, audio capture  
22 and analysis, and PCMCIA i/o. Context switches must be  
23 accomplished within a guaranteed time for this to be  
24 effective. Normal multitasking facilities are  
25 provided, such as message passing, mailboxes,  
26 preemptive/round-robin/time-slice scheduling, interrupt  
27 handling, etc.

28  
29 Various communication protocol stacks may be supported  
30 by the RTOS. Preferably, TCP/IP is implemented as the  
31 high level network communications protocol. This  
32 allows each camera to be assigned a unique internet  
33 address and simplifies communications between cameras,  
34 and between cameras and host PC's, across multiple  
35 heterogeneous networks.  
36

1 The advantages of the invention and/or the ways in  
2 which the disadvantages of previously known  
3 arrangements are overcome, include the following.

4

5 1. General

6

7 The Digitally-networked Camera is designed for real  
8 time video capture, compression, analysis and  
9 transmission in circumstances where it is either  
10 impractical or not cost effective to use a host PC.  
11 Since the camera operates stand-alone it can be plugged  
12 directly into computer networks or deployed remotely in  
13 the field using wireless communications.

14

15 2. Security & Surveillance

16

17 The digitally-networked camera contains the total  
18 functionality required for analogue-networked  
19 surveillance systems to migrate to digitally-networked  
20 systems. Real-time video/audio compression allows  
21 continuous transmission over existing LAN's without  
22 significant degradation in LAN performance.

23

24 Since the Digitally-networked Camera performs real time  
25 image processing, specific events can be detected and  
26 reported to personnel. This will dramatically raise  
27 the effectiveness of surveillance. The audio option  
28 can be used to assist in detection of certain security  
29 events including shrieks, breaking of glass, etc.

30

31 Thus, the invention allows semi-automation of security  
32 surveillance systems. This has the potential to  
33 significantly improve the cost-effectiveness of such  
34 systems.

35

36 3. Traffic monitoring

1 The Digitally-networked Camera can be programmed to  
2 analyse traffic speeds, congestion, vehicle  
3 numberplates, etc and can directly report these  
4 statistics and/or compressed video to a control centre  
5 via a WAN, eg an ISDN/phone line.

6

7 4. Video-Conferencing

8

9 The Digitally-networked Camera can participate in PC-  
10 based video conferences, transmitting compressed video  
11 from locations where PC's cannot be used, such as  
12 construction sites (wireless LAN) and factory shop  
13 floors.

14

15 5. Industrial Inspection & Process Control

16

17 The invention allows automation of industrial  
18 inspection, integrated with existing LAN's for  
19 communication of inspection results to controller PC's  
20 and control of cameras from PC's.

21

22 6. Miscellaneous

23

24 The wide range of PCMCIA cards available allows a  
25 diverse range of applications to be addressed. For  
26 example, to match images captured remotely with the  
27 location at which they were captured it is possible to  
28 use a GPS receiver card to let the camera get a fix on  
29 the position of capture. This might be combined with a  
30 cellular comms card to transmit the picture+location  
31 immediately back to base.

32

33 Improvements and modifications may be incorporated  
34 without departing from the scope of the invention as  
35 defined in the Claims appended hereto.

36

## 1     Claims

2

3     1.    A video camera comprising a housing enclosing  
4     video image sensor means adapted to generate a video  
5     signal, signal processing means adapted to process said  
6     video signal and to output a digital data signal, and  
7     digital interface input/output means adapted to  
8     transmit said digital data signal to an external,  
9     digital communications network in accordance with a  
10    predetermined communications protocol.

11

12    2.    A video camera as claimed in Claim 1, wherein  
13    said signal processing means includes a video signal  
14    processor (VSP) adapted to perform real-time image  
15    compression and/or image analysis on said video signal.

16

17    3.    A video camera as claimed in Claim 2, wherein  
18    said signal processing means further includes  
19    microprocessor means adapted to supervise operation of  
20    said VSP and data input/output via said interface  
21    means.

22

23    4.    A video camera as claimed in Claim 3, wherein said  
24    microprocessor means comprises a multi-tasking RISC  
25    processor.

26

27    5.    A video camera as claimed in Claim 2, wherein said  
28    VSP has first memory means associated therewith.

29

30    6.    A video camera as claimed in Claim 5, wherein said  
31    first memory means comprises dynamic random access  
32    memory.

33

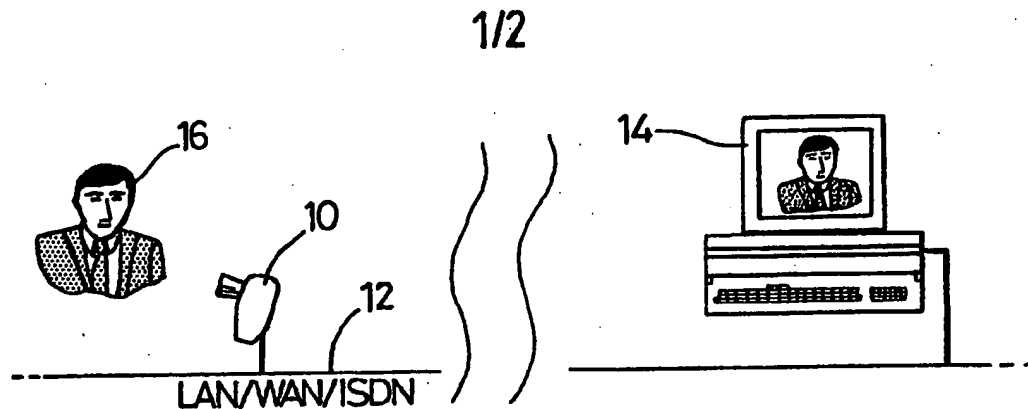
34    7.    A video camera as claimed in Claim 3, wherein said  
35    microprocessor means has second memory means associated  
36    therewith.

1 8. A video camera as claimed in Claim 7, wherein said  
2 second memory means comprises static random access  
3 memory and programmable read only memory.  
4

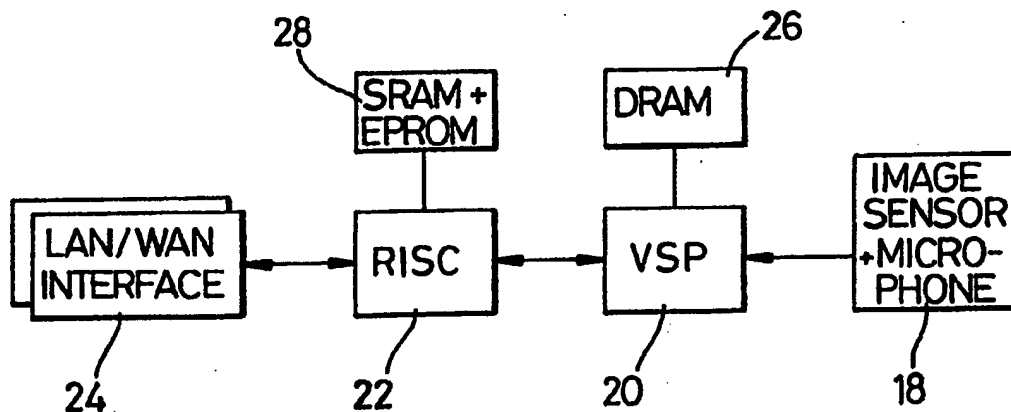
5 9. A video camera as claimed in Claim 1, wherein  
6 said communications protocol is TCP/IP.  
7

8 10. A video camera as claimed in Claim 1, wherein said  
9 interface means comprises at least one PCMCIA card.  
10

11 11. A video camera as claimed in Claim 1, further  
12 including audio sensor means, wherein said signal  
13 processing means is further adapted to process audio  
14 signals generated by said audio sensor means.  
15



**Fig. 1** THE CAMERA INTERFACES DIRECTLY TO LAN/WAN AND THEREBY CAN OPERATE UNDER CONTROL OF ONE OR MORE ATTACHED PCs / WORKSTATIONS.



**Fig. 2** HARDWARE ARCHITECTURE OF INVENTION ALLOWING CAMERA UNIT TO ATTACH DIRECTLY TO DIGITAL NETWORKS.

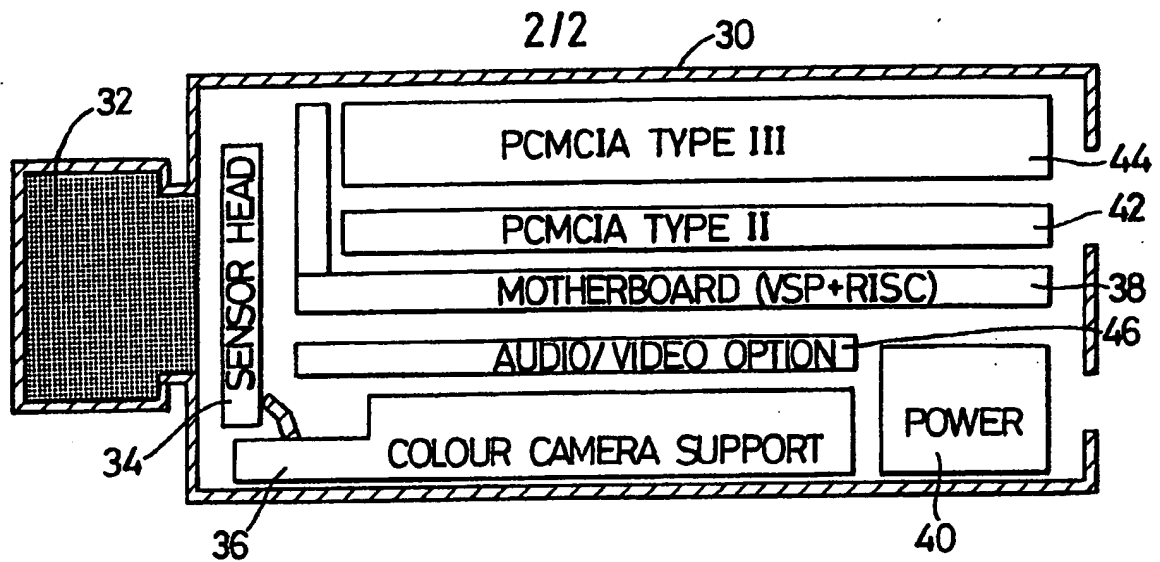


Fig. 3 PHYSICAL CONFIGURATION.

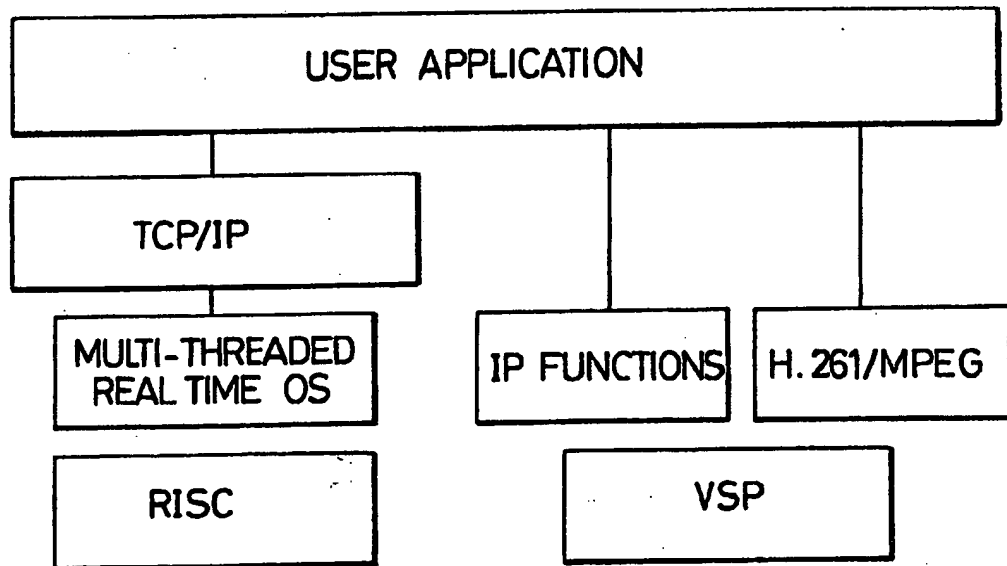


Fig. 4 SOFTWARE ARCHITECTURE OF CAMERA,  
ALLOWING IMAGE ANALYSIS IN CONJUNCTION  
WITH IMAGE COMPRESSION AND TRANSMISSION  
OVER DIGITAL NETWORK.

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 H04N5/232

According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04N

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Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PROCEEDINGS OF THE SPIE, vol. 1989, 24 - 24 July 1993 BELLINGHAM, USA, pages 88-102, A. MCLEOD ET AL. 'Applications of intelligent cameras'	1-3,5-8
Y	see page 89, paragraph 1.3 'Integrated systems'; see page 91, paragraph 3.1 'Modular architecture' to page 94, paragraph 3.9 ' Other modules'; see figure 1 --- -/--	4,9,10

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PROCEEDINGS OF THE SPIE, vol. 2173, 9 - 10 February 1994 BELLINGHAM, USA, pages 178-188, MCCARTHY ET AL. 'High-Performance Image Processing System' see page 186, paragraph 3.2.2. ' Computer Image Processing'; see figure 2 ----	9
X	WO,A,91 07850 (ZONE TECHNOLOGY) 30 May 1991 see page 2, line 14 - page 3, line 22 see page 4, line 5 - page 6, line 1 see page 7, line 1 - line 29 ----	1-3,5-8, 11
Y	ELEKTRONIK, vol. 42, no. 19, 21 September 1993 pages 102-108, 114/115, XP 000395519 MÖLLE S 'KOMPAKT UND FLEXIBEL' see page 104, paragraph 'Vision Controller: Steuerprozessor und Schnittstelle zur Aussenwelt' ----	4
P,Y	EP,A,0 617 542 (CANON KK) 28 September 1994 see column 4, line 41 - column 5, line 15 ----	10
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EP-A-0617542	28-09-94	JP-A- 6276471	30-09-94
US-A-5319751	07-06-94	DE-A- 4244266	01-07-93
		GB-A, B 2262825	30-06-93
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		US-A- 5404494	04-04-95
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